EXHIBIT B

IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
V.	)	No. 05-CV-329-GKF-SAJ
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

REPORTER'S TRANSCRIPT OF PROCEEDINGS

FEBRUARY 19, 2008

PRELIMINARY INJUNCTION HEARING

VOLUME I

BEFORE THE HONORABLE GREGORY K. FRIZZELL, Judge

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information, we still don't have it. How much have you charged to date, sir?

A. I believe the number is about $400,000 over three and a half years.

Q. In your lines of evidence, you talked about doing a review of technical literature?

A. Yes, sir.

Q. Which led you to the conclusion that there's a high concentration of E. coli, Salmonella and Campylobacter in poultry waste?

A. In poultry operations and poultry waste.

Q. In poultry operations and in poultry waste. Well, we know, for example, that one of the reasons that we want to thoroughly cook chicken is because of the possibility of Salmonella; right?

A. Yes, sir.

Q. Chicken can either come to your kitchen with the Salmonella or it can acquire it when it's in your kitchen out on the countertop; is that right?

A. I suppose that it can. I don't believe that's the most likely situation.

Q. Every warm-blooded mammal is a reservoir of E. coli; is that right?

A. I would say that's true, yes, sir.

Q. Each one of us here -- all but one of us here in this

courtroom would be considered a reservoir for E. coli?
A. I certainly am. I can't speak for anyone else.
Q. Well, as a toxicologist, you know that to be so, don't you, sir?
A. Yes, sir. And that's why we do contribution analyses to sort through these kinds of issues.
Q. And cows are a big producer of E. coli, aren't they?
A. Can be in certain circumstances.
Q. Various kinds. In fact, don't they produce some of the most hazardous kinds of E. coli on occasion?
A. Can.
Q. And the fact that you find E. coli in the watershed really just tells you that you have E. coli in the watershed; isn't that right?
A. If that was the only question that you asked, it would tell you only that but --
Q. That's the one I'm asking now.
A. But that's not where I stopped.
Q. And the fact that you found Campylobacter in the watershed would tell you that something was a source of Campylobacter in the watershed; is that right?
A. If you found it there, you would. But the fact that you don't find it there is not an indication that it is not present.
Q. Now, I want to visit with you about that a minute. You

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REPORTER'S TRANSCRIPT OF PROCEEDINGS

FEBRUARY 21, 2008

PRELIMINARY INJUNCTION HEARING

VOLUME III

BEFORE THE HONORABLE GREGORY K. FRIZZELL, Judge

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so drying out. And again, it's very hard to say, it depends on a lot of common conditions that the bacteria encounter. If they are exposed fully to ultraviolet radiation and desiccated, it may take only a matter of hours for them to be permanently inactivated or killed. On the other hand, if they're shielded from radiation, if they're provided with some moisture, then they may persist for up to months at a time.

THE COURT: Thank you. Mr. Page.

MR. PAGE: Thank you, Your Honor.

Q. (By Mr. Page) So those bacteria can remain viable for months at a time if they have certain environmental conditions available?

A. That's correct.

Q. At the same time, if you use a standard method to try to identify that bacteria in the environment, it wouldn't necessarily be culturable?

A. That's correct, because the bacteria may be surviving and persisting in the environment, but they may be stressed to the point where they won't grow on this basically artificial growth substrate that we're providing them.

Q. Now, if a pathogen such as Campylobacter goes into this viable but not culturable state, can it then also remain as a hazard to human health?

A. Yes, studies have shown that viable but non-culturable organisms, when passed into a host such as perhaps if they were

Q. I think that's very important, so let's address those. So, for instance, in a field, a bacterium could be affected in its die-off rates by sunshine, oxygen, temperature changes, humidity changes, pH changes, salinity changes, predation changes and time?

A. Correct.

Q. All those things would kill bacteria at different rates?

A. Kill or inactivate or make non-viable.

Q. And a moment ago I believe you said that sunlight typically kills bacteria if it can reach the bacteria within two hours. Do you remember saying that?

A. Well, no, I didn't say if it would reach the bacteria within two hours. I said it would kill it within a couple of hours, that's a broad estimate, if the bacteria were directly exposed.

Q. Were directly exposed. So if I can use an example, in a cow pie -- this is kind of an embarrassing case and I'm just going to launch ahead.

A. Not to me.

Q. A cow pie is a little pie with a crust. Isn't it true that the bacteria inside that cow pie are protected from the sunlight or at least partially protected?

A. Yeah, yes.

Q. So they would die off at a much slower rate --

A. Than what?

Q. -- than if they were spread out on a field?
A. Correct.
Q. And if you were to spread out bacteria on the field in a thin, fine dust and thereby expose them to sunlight, those would die within a few hours?
A. Well, that depends on what you mean by a thin, fine dust.
Q. Thin enough that they could see the sunlight, they could be exposed to the sunlight?
A. If they are directly exposed, then they -- we're going to have a pretty high inactivation rate as long as they don't make it into the soil. If they do make it into the soil, then they'll be protected.
Q. And in talking about those same factors, dryness kills bacteria. I believe you used the word desiccation by that, but you mean dryness; right?
A. Correct.
Q. And that kills bacteria?
A. Correct.
Q. So the same thing, a cow pie shelters bacteria by keeping in the moisture; is that right?
A. Compared to?
Q. Compared to a thin dust?
A. Yeah, compared to a thin dust.
Q. Now, you're not offering an opinion in this case as to the relative rates of movement of bacteria that you've studied and

Q. (By Mr. Jorgensen) Was the question that you were trying to address in this case, Dr. Harwood, whether bacteria that are found in the streams, whether those came from poultry litter? Is that the question you were trying to address?

A. Not directly whether bacteria that came from one particular field were in one particular stream, but whether there was a gradient of these signals from one compartment, in other words, from one type of sampling entity to another.

Q. So the bacteria that you find in a stream, E. coli, let's take that for example, they could come from cattle; right?

A. In certain streams there would be some possibility for contamination from cattle.

Q. They could come from birds?

A. There could be a bird component.

Q. If you found Salmonella, it could come from reptiles?

A. Salmonella has been isolated from reptiles.

Q. So if you found Salmonella in the streams of the Illinois River Watershed, it could come from reptiles? I'm not trying to trick you with these questions. I'm actually trying to clarify what you did.

A. So if I found Salmonella at an edge of the field sample I would --

Q. If you found Salmonella in the streams of the Illinois River Watershed, they could come from reptiles?

A. They could come from other sources other than -- than that

field, yes.
Q. And it was your job to help the plaintiffs understand whether the bacteria that you found in water, groundwater or streams, whether it came from poultry litter?
A. It was my job to determine whether or not there's a correlation between the practices of land applying this poultry litter and the contamination that's appearing in streams, that's how I would phrase it.
Q. And you did not do that through a traditional fate and transport analysis, you did it through the microbial source tracking we were just talking about?
A. We did the microbial source tracking, yes, as a way of determining whether or not we had a specific poultry litter signature in that water.
Q. All right. Now, let's talk for just a moment about the animals that live in the Illinois River Watershed. Pigs carry Campylobacter; is that true?
A. Pigs are not well-known to carry Campylobacter. I'm sure there's been a couple of studies that have found them.
Q. And Salmonella also, don't pigs also carry Salmonella?
A. Yes, pigs carry Salmonella.
Q. Most reptiles, I think we established, carry Salmonella?
A. I wouldn't say most reptiles, but I know they've been isolated from some.
Q. Humans contribute fecal matter to the Illinois River

Watershed directly?
A. Hopefully not.
Q. You don't know whether they contribute it directly?
A. No, I don't know.
Q. Let's look at page 186, line 14 of your deposition. Page 186, lines 14 to 21.
(An excerpt of the videotaped deposition of Valerie Harwood was played.)
Q. "So humans can contribute fecal bacteria to waterways directly?
A. "Directly, yeah, and also through their waste disposal systems.
Q. "Okay. And are septic systems a potential source of fecal pathogen contamination?
A. "Septic systems can be if they're not properly constructed to be separated from the water table."
Q. (By Mr. Jorgensen) Dr. Harwood, you haven't studied how many species of animals live in the watershed, have you?
A. No.
Q. You don't know how many types of birds live in the watershed?
A. No.
Q. You haven't studied the migration patterns of birds through the watershed?
A. Not directly, no. I've had some information on it, but I

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REPORTER'S TRANSCRIPT OF PROCEEDINGS

MARCH 7, 2008

PRELIMINARY INJUNCTION HEARING

VOLUME VI

BEFORE THE HONORABLE GREGORY K. FRIZZELL, Judge

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Q. So what do you conclude in terms of whether the chicken toxin producing E. coli 0157H7 is going to be sourced from poultry?

A. I say within reasonable medical probability and reasonable epidemiologic probability chickens ain't the source.

Q. Okay. So what are the pathogens then that we should be concerned about with respect to poultry?

A. We have to focus on Salmonella and Campylobacter, the established organisms that have a clear poultry reservoir.

Q. Well, let's just go back to E. coli for a moment even though you said they're not in poultry. I just want to understand -- the term E. coli has been used in this hearing frequently and I want to see if you will distinguish for us the E. coli bacterial indicator as opposed to the E. coli that causes human disease.

A. Yes, there are actually about six different diarrhea producing E. coli. This is one of them. It's actually probably the least important, this one is, from a number standpoint worldwide.

Q. By this one, you're referring to 0157?

A. This 0157H7. It's important now it's in the newspapers because it's produced such serious problems in spinach and lettuce, but it's a relative small problem with 70,000 cases in the U.S. each year. But the E. coli, their indicator organisms are like the E. coli that lives in every colon, every large

intestine of everybody in this room and it's what we flush in our toilets, down our toilets every day. And those bugs do not produce disease. They're totally avirulent. They're very good bugs, they make Vitamin K for us and they're very effective in inhibiting pathogens from causing illness. Those are good bacteria.

Q. Have you seen in the work that you've done in this case, have you seen any indication that one of these pathogenic E. colis is present in the Illinois River Watershed?

A. There's no evidence for this.

Q. All right. Now, we've talked about Campylobacter and Salmonella as the two bacterias we focused on. Now, can you tell us how they make one sick, how does that happen?

A. Yeah, all microbes have a target organ and that's the organ. Hepatitis is liver. West Nile is brain. These bugs, Salmonella and Campylobacter, infect the gut. You have to swallow them to be sick. That's the only way you can get sick with these bugs is to swallow the organisms. Now, after you say that, there are two factors that are important in infectious diseases when you look at microbes. One is dose, the other is virulence. Virulence has to do with the aggressiveness of the organism, the ability to produce disease in people. It varies by organism and by strain, but those are the two factors, dose and virulence, and then the target organ that has to be infected.

Q. Let's talk a little bit about indicator bacteria. And with that, let's bring up slide number 7, please. Could you tell -- I know His Honor has heard quite a bit about bacteria, but just talk to us for a moment about prevalence of bacteria in humans and animals.

A. Well, we have -- the human being has a hundred trillion, 10 to the 14 bacteria that live in and on the skin, in the mouth, in the GI tract, vagina, all the parts of the body. I mean, we're like the Peanuts character, Pigpen. We've got this cloud of microbes around us and by the way, we like those microbes. They're good for us. When we take antibiotics and knock those bugs down, we are then more susceptible to other problems. So those bugs are great for us. Now, humans are really the most important source for human infection. They're the most important and --

Q. Excuse me, I'm sorry.

A. And when you -- when I was talking about water sources as the cause of human disease, swimming pools and wading pools are contaminated by other people. And this is why they're at such high risk when they're not properly chlorinated.

Q. Is it feasible to have a water standard that says there can be no bacteria in the rivers or the streams or lakes?

A. You cannot have that. There are wild animals, there are people, there are reasons why there will be microbes. And I don't think it's a good idea to have a sterile world. And

maybe this is where I'm irresponsible again or whatever the term was, you'll remember the word.

Q. You're being a little thin skinned here.

A. Okay. Well, I'm okay with that. But anyway, if you put a person in a bubble and you don't expose them to microbes until they're adults and put them out in the world, they will die. We are adapted to microbial challenge at all times. You put a kid in a daycare center, they have a couple of episodes of diarrhea, but they have less infections later in life than kids not put in daycare centers. So there's a certain microbial load that we must be exposed to to rev up our body's immunity and to be able to handle infection. And we do not want a sterile world.

Q. In that connection, I think what Dr. Lawrence said you were irresponsible about was you said something in your affidavit about the fact that people develop immunity if they are exposed to low level pathogens. Is that a fair statement?

A. That's exactly what he --

MR. BULLOCK: Objection to form, that's not what he said.

MR. RYAN: Well, let's get it exactly right then, Your Honor. I'll rephrase it and we'll put it on the screen.

Q. (By Mr. Ryan) Can you see that, Doctor --

A. I can see it, but I don't see where it is yet.

Q. All right.

A. Oh, this is my stuff.
Q. This is your affidavit.
A. Okay.
Q. Page 18, paragraph 14.
A. Okay.
Q. If you'd read beginning with following, if you can.
A. "Following repeated exposure to a specific strain of bacteria, parasite or virus that may be encountered in water, the exposed persons characteristically develop immunity to the organism and related organisms. This is seen in the persons living in mountainous areas of the U.S. and Colorado, Alberta, Utah, who are quite resistant to Giardia as they have been exposed before to the parasite in the local water sources. On the other hand, visitors to the region are susceptible to the parasite and may become ill after exposure to contaminated persons, water or food. Is that enough?
Q. Yes. Were you recommending people drink water with microbes in it?
A. That's what was taken totally out of context. I was describing what happened, not what was good about it. I was just saying this happens. I wasn't recommending anything.
Q. It's just a medical fact?
A. Yes, this is what happens.
Q. All right. Now, let's turn to indicator bacteria that His Honor has heard about, enterococcus and E. coli and fecal

coliforms. But what is the significance of indicator bacteria or its presence?

A. Well, it depends -- you know, you can't just jump on it real quick. If it's human feces, that's what you're looking at as indicator organisms, there could well be pathogens there that could cause disease for reasons that we've already been through this morning. The other thing would be if there's a pathogen there in sufficient dose. And water tends not to have high dosage or even moderate doses, it has low doses. So if there's a high -- a relatively high inoculum of organisms there, sufficient inoculum, you could have illness. But the most important part is whether it's human feces or animal feces that's present.

Q. Let me change topics altogether here.

THE COURT: Before we do that --

MR. RYAN: Sure.

THE COURT: -- because this is an important subject here and it's not been quite clear to me. Typically the tests for indicator bacteria are not specific to humans versus poultry versus cattle feces; correct?

THE WITNESS: Correct.

THE COURT: All right. Go ahead.

Q. (By Mr. Ryan) Do you know how the EPA developed those standards, what testing they did to develop those standards?

A. Yes, there were a couple of places, two specifically where

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REPORTER'S TRANSCRIPT OF PROCEEDINGS

MARCH 10, 2008

PRELIMINARY INJUNCTION HEARING

VOLUME VII

BEFORE THE HONORABLE GREGORY K. FRIZZELL, Judge

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it's as evenly as possible spread across the field. It's kind of like a dust, you know, like maybe spreading pulverized lime on your yard. It just goes all over.

Q. Did you hear Dr. Harwood's testimony about what sunlight will do to that dust?

A. I believe she said that exposure for two hours would kill the bacteria.

Q. In addition to sunlight, does the fact that it's a dust influence the bacteria in any way?

A. Absolutely. Desiccation, it will dry out much quicker in that form.

Q. Let me put State's Exhibit 405 back up. Doctor, have you heard testimony about the State's edge-of-field sampling?

A. I have.

Q. Have you heard anything about whether cattle were on those fields?

A. It's my understanding that cattle were on those fields.

Q. Is that important to establishing or disproving a link between poultry litter and contamination in the water?

A. Of course. There's an enormous impact from cattle on the water quality indicator concentration. I would suspect that you're going to have relatively high edge of field samples when cattle are present --

Q. Let's explore your basis for that opinion. Let me bring up Defense Exhibit 95. Do you have it there in front of you?

bacteria are nonmotile, there would have to be a large rain storm to move them.

Q. Has the State studied, to your knowledge, the amount of rain it would take to move the bacteria?

A. Not that I'm aware of, no, sir.

Q. Do different types of soil in the field have different effects on the different types of bacteria?

A. Absolutely.

Q. Does vegetation filter bacteria?

A. Oh, it certainly does. Riparian buffers are an excellent best management practice tool to put in place to prevent bacteria from entering the water.

Q. Okay. Now, we've talked at the edge of these fields about cattle and about poultry litter. Are there any other possible sources of indicator bacteria or pathogens in the IRW?

A. Well, sure, these indicators are associated with any warm-blooded mammal. There are birds, rodents. You'll get deer, you'll get skunks, you get opossums, you get --

Q. Let's bring up State's Exhibit 221. Hang on, it will come on the screen in just a second, Doctor. This is the affidavit of Dr. Billy Clay. Are you familiar with this, Doctor?

A. I looked over it, yes.

Q. Are you familiar with the list of animals listed in this exhibit, Doctor? Let's go to, in the exhibit, page -- it will take me just a second to come up with it. Let's put up this

list for now. And in the meantime, let's be looking for the other list. Yes, thank you so much. Are you familiar with this list, Doctor?

A. I am.

Q. Would each of these animals be a potential contributor?

A. Absolutely, yes.

Q. Let me focus on some of the smaller animals that you've mentioned. You've mentioned deer, you've mentioned sheep, I believe you mentioned geese and ducks. Now, could those really be a significant source of either pathogens or indicator bacteria in surface water? I mean, there are so many fewer than other types of animals?

A. I'd agree they're so much fewer when you take a look at the amount of manure generated. But it is, in my opinion, a huge mistake to discount those sources. Proximity trumps quantity when it's further away. The fate and the transport is such a key issue here. You know, the proximity really is the key. And time and time again in our source tracking work in our studies, we have found dominant sources to be -- when I say dominant, 20, 25 percent, avian, small mammal, rodents. You know, those sources that are defecating at or in the stream, they play such a huge role because they're not subjected to all the, potentially, kill steps along the way into making it into the waterway. So those are absolutely huge. But even when you take a look at the major contributors, I mean, you'll see that

in terms of cattle versus the poultry, there's seven times more fecal matter generated by the cows than the poultry.

Q. Now, Doctor, on that point that there's more fecal matter generated by cattle, I believe we had some discussion yesterday, though, that the cattle manure is wet and whether that makes a difference. Does it make a difference in how microbes like bacteria live, prosper or die if the cattle manure is wet?

A. Well, not only it's wet, it's protected. It's in a nice pattie. So they're growing really well, so they're multiplying.

Q. All right. The fact then that the cattle manure is stated in wet tons, does that make it a better home for bacteria, more of a risk for bacteria or less of a risk for bacteria?

A. I don't think the way you state it in wet tons or dry tons really affects how the bacteria grow. You know, the label is irrelevant. What I think is important is that because the manure is wet, it's going to be growing.

Q. All right. While we're talking about --

A. And you know, when the poultry is dry, it's not.

Q. While we're talking about wet versus dry, did you hear Mr. Lennington talk with Dr. Jaffe about the word CAFO?

A. I did.

Q. Do you have experience with CAFO's?

A. I do.

Q. What is a CAFO?
A. Combined animal feeding -- concentrated animal feeding operation.
Q. Is that a regulatory term?
A. Oh, it is, it is. We have to include the CAFO and CAFO load allocations, discharge allocations in our TMDLs as part of the waste load allocation process.
Q. I believe Mr. Lennington asked Dr. Jaffe about CAFO's where the herd would contribute feces that would then be a home for bacteria. Did you hear that same thing?
A. I did.
Q. Have you ever heard poultry referred to as a herd?
A. No, poultry is a flock. It was clear to me that reference was to cattle. And I believe that with maybe one exception, there are no poultry CAFO's in the IRW.
Q. Doctor, let me turn you now to Defense Exhibit 57. I believe you were talking about direct deposit, were you not, and the importance of direct deposit just a moment ago? Just to pick up our train, Doctor, what is the importance of direct deposit, if any, to a fate and transport study?
A. Well, direct deposit, they're there, they're in the water, they're immediately innumerable. You're going to count them from the time of deposition. They don't die on their way in. They're not subjected to the UV. They're not subjected to the desiccation. They're not -- there's no time in the transport

to get eaten by the protozoa and the predation.
Q. Dr. Myoda, of the animals listed here on Defendants' Exhibit 221, which of them directly deposit into surface water?
A. Well, the cattle, especially in the summer when it's hot, they like to be in the water just like we like to recreate in the water. So they'll cool off, they'll drink. A lot of the others, the deer and wildlife, they'll go down to the waterways and drink. I guess I'm recalling Dr. Harwood's testimony, you know, the geese and the ducks defecate in the water as well.
Q. Doctor, we have to go to what is my favorite study in this whole case because it reminds me of my youth. Let me refer you to Defense Exhibit 57 by Professors Davies and Colley, Water Quality Impact of a Dairy Cow Herd Crossing a Stream. What did Drs. Davies and Colley or, perhaps it's one and I'm saying it twice, but what was studied in this study? What was the topic?
A. Well, dairy cows and when they walked across the stream and when they were in the stream, what effect it had on water quality.
Q. And did the authors discover anything about cattle preferences for where they use the bathroom?
A. They were 50 times more likely to do it in the stream.
Q. Thank you. All right. Doctor, let me turn to the State's microbial source tracking approach here. Have you reviewed the State's use of microbial source tracking in this case?
A. I have.

IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
V.	)	No. 05-CV-329-GKF-SAJ
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

REPORTER'S TRANSCRIPT OF PROCEEDINGS

MARCH 11, 2008

PRELIMINARY INJUNCTION HEARING

VOLUME VIII

BEFORE THE HONORABLE GREGORY K. FRIZZELL, Judge

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A. Yes, I did.
Q. Let me refer you to the last exhibit in the series, Demonstrative Exhibit 8.
A. The same presentation. Again, we don't see a particular difference in the Illinois River Watershed compared to the rest of the state. I would point out that the five orange bars that you see clustered around the Illinois River Watershed, actually just one of those is inside the watershed. The other four are just outside the watershed boundaries.
Q. You can retake your seat, Dr. Sullivan. I appreciate you explaining that. Dr. Sullivan, based on the information that you've reviewed and what you've just discussed with the Court, do the locations of fecal indicator bacteria impairment in the state correlate well with the areas of poultry production?
A. I don't see that that's the case, no.
Q. Based upon the information you've reviewed, are the areas with the highest levels of fecal indicator bacteria impairments in the state correlated well with areas of poultry production?
A. No, they're not.
Q. Now, Dr. Sullivan, have you evaluated the potential sources of fecal indicator bacteria in the watershed besides poultry litter?
A. Yes.
Q. And could you identify for the Court based upon the information that you've reviewed the other significant

potential sources that you've identified?
A. Well, I think the most significant sources would be people and cattle. We've talked a lot about cattle in this hearing so far, not so much about people. In terms of sources from people, there are many possible routes of fecal indicator bacteria that are derived from human feces to make their way into waterways, and then also derived from human activities other than human feces. Key in that regard would be urban runoff, which has been well-documented in terms of contributing to fecal indicator bacteria in streams. As well as urban runoff, we have septic systems that have been discussed. There's a chronic input of bacteria from wastewater treatment systems, and then there are periodic problems with those, overflows and that sort of thing, sewage breaks. So there are a number of potential sources of fecal indicator bacteria from people that are important. Other sources besides the cattle and the people would be things like wildlife and other livestock.
Q. Okay. Dr. Sullivan, in addition to just thinking about people globally, have you looked in this watershed at the areas in which the human population is concentrated in urban areas?
A. Yes, I have.
Q. Let me refer you to Demonstrative Exhibit 13.
THE WITNESS: Your Honor, may I approach? Thank you.
Q. (By Mr. George) Dr. Sullivan, can you explain what is

Demonstrative Exhibit 13?

A. This is a map of land use from USGS data, Natural Land Cover Dataset. I think this is really key to understanding what is happening in this watershed, particularly with respect to the areas of concentration of people. The areas in the light blue color are the urban portions of the watershed. We have a number of smaller urban areas distributed around the watershed, but as we all know, the human populations are mostly concentrated in the eastern part of the watershed. And this is the upstream end of the watershed. And then we have the agricultural areas that are in orange, and the green and other are presumably more natural vegetation is in green. The triangles here are the locations of the wastewater treatment outflows.

Q. Dr. Sullivan, you've identified the urban areas as being in what I would refer to as the headwaters of the watershed; do you agree with that?

A. Correct.

Q. Is that significant scientifically?

A. It is significant. It's quite unique. The watersheds that I've studied in the past, none of them have been like this. And the reason it's unique is because in the headwater areas we have what I consider to be some of our most important sources of water pollution including fecal indicator bacteria. Typically what you find, at least in the watersheds that I've

studied, is that in the upper portion of the watershed, you tend to have more natural kinds of vegetation, perhaps forested vegetation, that sort of thing, and that as you move down through the watershed, then you have influence of things like urban areas, agricultural activities and some of the things that are associated with potential sources of pollution. So in this situation, we have the opportunity for urban pollution right from the git-go, right at the top of the watershed. That makes it very difficult to evaluate what is happening as we move down through the stream systems and we have other potential sources of pollution added to the streams.

Q. Dr. Sullivan, can you explain to the Court the mechanisms through which urban runoff can deliver fecal indicator bacteria to the streams?

A. Yes. Urban runoff can deliver bacteria disproportionate to its land area. This is a really important issue, and it has been well-described in the scientific literature. It has to do primarily with the fact that so much of the water that comes down in rain is short-circuited through the urban environment, through the storm drain systems and into the streams, and this is a function of the large percentage of impervious area in urban areas. These are areas where rainfall could not percolate down into the soil. It's rooftops, it's sidewalks, streets, parking lots, construction areas. All these areas where the rain comes down, it can't go down into the soil, has

no way to go, nowhere to go, and people like to route it out of the city as quickly as they can through the storm drain systems. That's why they are there. The reason it's important is because as water percolates down through the soil, it's a very efficient filtering mechanism for many pollutants, including fecal indicator bacteria, but with the short-circuiting you have in urban environments there's little opportunity to that to take place. And so you're picking up all the fecal material from dogs, and cats, and wildlife, deer, whatever. Whatever is in that environment short-circuited and moved directly into the stream.

Q. Retake your seat, please. Dr. Sullivan, are there, in fact, studies that exist in the scientific literature that discuss the importance of urban runoff on fecal indicator bacteria levels?

A. Yes, it's very well-described in the scientific literature. In fact, there was an urban storm -- storm water study by EPA in 1983 where they looked at this issue nationwide and their conclusion was that typical concentrations in urban areas were above 10,000 CFUs per hundred mil. They can be quite high.

Q. Is the urban population in this watershed really large enough to make it important as a contributor of fecal indicator bacteria?

A. I believe that it is, yeah.

Q. Have you actually reviewed population data for the watershed and cities that are located within it?

A. Yes.

Q. Let me refer you to Demonstrative Exhibit 15.

THE WITNESS: Your Honor, may I approach the picture?

THE COURT: You may.

Q. (By Mr. George) Dr. Sullivan, do you recognize Demonstrative Exhibit 15?

A. Yes. First of all, let me state that the total human -- estimates of the total human population in the watershed is around 300,000 people. So there are quite a few people in the watershed. What I've attempted to do here is to look at the changes over time and the population and these are the cities on the Arkansas side of the watershed in looking at census data from 1980, 1990 and 2000, and they have quite rapid growth in population. As a matter of fact, northwest Arkansas in the '90's was the sixth largest growing metropolitan area in the United States. So the population growth has been quite extreme. And that makes a big difference in terms of the amount of construction that's going on, and that's certainly something that I've observed in the watershed is that in that easternmost upper end of the watershed there's a great deal of construction, and that provides a lot of this impervious area that I was talking about before.

Q. Dr. Sullivan, if you could retake your seat. Thank you.